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54 Title: Device for treating respiratory tract with warm air

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Claims

1. Device for the treatment of respiratory tracts with warm air, in which, upstream of a mask that is placed on the patient's face there is a space that is provided with a heater device, and a liquid reservoir can be inserted into the current of warm air, wherein a hygrometer (68) is provided downstream of the liquid reservoir (28) in the direction of flow of the warm air to measure the relative humidity of the current of warm air, which hygrometer (68) controls a display device (69, 70) that can be read from outside.

2. Device as recited in Claim 1, wherein the hygrometer (68) is located upstream of the mask (20) that is placed on the patient's face in the direction of flow of the air.

3. Device as recited in Claims 1 or 2, in which there is a connecting piece between the space that contains the heater device and the mask that is placed on the patient's face, wherein the hygrometer (68) is located on said connecting piece (21).

4. Device as recited in Claim 1, which is also provided with a reservoir for a vaporizable medication, wherein the hygrometer (68) is located between the reservoir (28) and the mask (2) that is placed on the patient's face.

5. Device as recited in one of the preceding claims, with a check valve that prevents any passage out of the mask into the area in front of it, wherein the hygrometer (68) is located upstream of this check valve (73) in the direction of flow of the warm air.

6. Device as recited in one of the preceding claims, the wall of which is provided with one or more optionally closable openings in the area between the space that contains the heater device and the mask that is placed on the patient's face for the passage of unheated air into the warm air current, wherein the hygrometer (68) is located downstream of said opening or openings (72) in the direction of flow of the warm air.

7. Device as recited in one of the preceding claims, wherein the wall area that holds the hygrometer and preferably has a circular cross section is provided with a nozzle-shaped extension (66), into which the hygrometer (68) is inserted.

8. Device as recited in Claim 7, wherein the nozzle (66) projects outward.

9. Device as recited in one of the preceding claims, wherein a preferably replaceable filter (55) is inserted into the current of warm air.

10. Device as recited in Claims 7 and 8, wherein the filter (55) is realized in the form of a paper filter that is inserted into the air current essentially transversely.

11. Device as recited in Claim 10, wherein the filter (55) is located in the vicinity of the entry into the connecting piece (21).

12. Device as recited in Claim 11, in which, on the side of the connecting piece facing the heating element, a ring-shaped sealing element made of elastomer material is provided, which is braced between a porous block that functions as the liquid reservoir and the connecting piece or an extension of the connecting piece, wherein the ring-shaped sealing element grips the filter paper (55) from behind in the peripheral area of the filter paper (55), and holds it in position.

13. Device as recited in Claim 1, wherein the hollow-cylindrical liquid reservoir (28) is provided with a fastening ring (51), the inner peripheral surface of which is provided with thorn-like projections (57).

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Device for treating the respiratory tract with warm air

This invention relates to a device for the treatment of the respiratory tract with warm air, in which a space that is provided with a heating device is located upstream of the mask that is placed on the patient's face and a liquid reservoir can be inserted in the warm air current.

A similar device of the prior art is described in DE-OS 21 60 561 has been widely used for many years with considerable therapeutic success. This success is due to some extent to the fact that this device also makes it possible to treat diseases of the respiratory tract, the treatment of which requires the inhalation of air that has a relatively high moisture content. Because to achieve an optimal effect, the use of the device can extend beyond brief periods of time, e.g. between 30 and 120 minutes, one objective is to ensure that the relative humidity required to achieve the desired therapeutic effect can be maintained within relatively narrow limits even over the desired period of time.

The object of the invention is therefore, among other things, to configure a device of the type described above so that under all conditions that occur during practical use, it is possible to monitor the relative humidity of the air that is inhaled by the patient without problems and without special conditions, and so that when the relatively humidity drops below a specified level, suitable measures can be taken, including but not restricted to the refilling of the liquid reservoir. An additional object of the invention is to retain the relatively simple construction of the device of the prior art.

The invention teaches that a hygrometer for the measurement of the relative humidity of the warm air current is located downstream of the liquid reservoir in the direction of flow of the warm air and controls a display device that can be read from outside the device.

This configuration makes it possible for the person using the device, or optionally for the medical personnel administering the treatment, to determine at a glance the relative humidity of the air that is being inhaled by the user, and optionally to take suitable measures to set the relative humidity to the desired value. In general, a relatively approximate display device will suffice, because a few percentage points of relative humidity more or less do not make much of a difference. However, it is possible without further effort or major technical expense to provide a hygrometer with a display device

which displays and makes readable the ranges that are important during therapy, for example so that the overall range can be divided into a range with normal relative humidity, a range with higher relative humidity and a range with below normal relative humidity.

The invention further teaches that the hygrometer can be located upstream of the mask that is placed on the patient's face in the direction of flow of the air. This arrangement prevents the air that is exhaled by the patient from influencing the relative humidity at the location in which the measurement is taken. If there is a connecting piece between the space that contains the heating device and the mask that is placed on the patient's face, it will be appropriate to locate the hygrometer on said connecting piece. If the device is also provided with a reservoir for a medication that can be vaporized, it is advantageous to locate the hygrometer between said reservoir and the mask on the patient's face, so that the portion of the relative humidity that is due to the medication is also measured by the measurement unit.

If the device is provided with a check valve that prevents passage out of the mask into the area that lies immediately in front of it, the hygrometer is advantageously located upstream of said check valve in the direction of flow of the warm air. Here again, the purpose is to prevent any influence on the measurement by the air exhaled by the user.

It is possible and known from the prior art that the wall of device in the areas between the space that holds the heater device and the mask that is placed on the patient's face can be optionally provided with closable openings for the passage of unheated air into the current of warm air. This configuration is used to regulate the temperature of the warm air current that is to be inhaled, optionally with the controlled feed of unheated air. The invention makes it possible to locate the hygrometer downstream of this opening or these openings in the direction of flow of the warm air, so that the relative humidity is measured in the resulting air current, which represents a mixture of heated and additional air that has been humidified with unheated air.

The wall area which contains the hygrometer and which preferably has a circular cross section, can be provided with a nozzle-shaped extension into which the hygrometer is inserted. The nozzle advantageously projects outward so that the display, even if it is relatively small, can be read easily by the user or by a third person. The hygrometer and display apparatus are preferably combined into a single assembly.

The invention also makes it possible to integrate a filter into the warm air current. One purpose of this filter is to remove any impurities in the air. This capability is particularly

important for dust particles. On one hand, the removal of such solid particles from the air improves the quality of the air that is inhaled by the patient. On the other hand, it also prevents any impurities in the air from settling in the hygrometer. This filter can be replaceable. In one particularly advantageous realization, the filter is realized in the form of a paper filter that is inserted essentially transversely into the air flow. Said filter can be located in the vicinity of the entry into the connecting piece.

If the device, on the side of the connecting piece that faces the heating element, has a ring-shaped seal element that is made of elastomer material, which is braced between a porous block that functions as the liquid reservoir and the connecting piece or an extension of said connecting piece, the ring-shaped sealing element can hold the edge of the filter paper from behind and hold it in position. This arrangement makes it possible to insert the filter paper without any additional measures, and also facilitates its replacement.

The filter paper can, to a certain extent, also function as a bacteria filter, although that will not always be the case if the objective is to prevent a significant increase in the respiratory resistance of the device. Nevertheless, the retention of solid particles already represents a significant improvement, especially with reference to the use of porous blocks as the liquid reservoir. It is true in general that the resistance to abrasion of such blocks decreases with increasing porosity and thus with increasing storage

capacity. The use of the filter therefore makes it possible to use relatively soft blocks or corresponding materials, because any material that may removed by abrasion will not be inhaled by the patient on account of the presence of the filter. Because the filter paper is extraordinarily cheap, its use in no way results in any significant increase in cost.

It is possible to use the device with a loose container that has a ring-shaped interior that is adapted to the hollow cylindrical reservoir body and can be filled with water, so that the reservoir body can be filled with water by immersing it in said interior. In this case, the arrangement can be selected so that a filter that preferably consists of filter paper is also placed on the top of the loose container, and the water is poured into the container through said additional filter. The additional filter in question can be a bacteria filter, so that not only solid particles but also pathogenic microorganisms can be removed from the water.

One exemplary embodiment of the invention is illustrated in the accompanying drawings, in which:

Figure 1 is a side view of a device for the treatment of respiratory tracts with warm air, shown in partial section.

Figure 2 is an overhead view of the display device of the hygrometer in the direction of Arrow II in Figure 1,

Figure 3 is a side view of the device, in an exploded view of the device,

Figure 4 is a side view of a corresponding container for filling the liquid reservoir, shown in partial section.

The exemplary embodiment illustrated in the accompanying drawings corresponds in its basic construction to the device that is described and illustrated in DE-02 21 60 561 and US-POS 38 29 545. It consists essentially of a mask 20 that is placed on the patient's face, a connecting piece 21 which encloses a chamber, and a part 23 that contains a heating element 22, which can simultaneously function as a handle. The heating element 22 is realized in a tubular shape and can be connected by means of a cable 24 to a voltage source. In its interior there is a thermostat 27. On the outside it is surrounded by a solid, porous body, e.g. by a filter block or similar object 28, which functions as a liquid reservoir.

The reservoir body 28 is enclosed by an inner wall 31 which forms respective ring-shaped chambers 33 and 34 with an outer wall 32 and the reservoir body 28. In the lower portion of the part 23 holes 35 are made, through which the air to be inhaled by the patient first travels into the ring-shaped chamber 34 and from there through the holes 36 in the inner wall 31 into the ring-shaped chamber 33. The air flows into the ring-shaped chamber 33 from below. The air travels through openings 37 and 38 into the inner chamber 40 enclosed by the heating element 22 and from there

through the connecting piece 21 into the mask 20 and finally into the patient's respiratory tract, because the mask 20 is in front of the patient's face. During the passage through the ring-shaped chambers 23 and 24 and the interior 40, the air is heated to the desired temperature, which can be set by means of the thermostat 27. Simultaneously the air flowing through the ring-shaped chambers 33 and 34 insulates the outer wall 32, so that any unacceptable heating of said outer wall 32 is prevented. On its prescribed path through the part 23, the air simultaneously absorbs humidity from the reservoir body 28. The latter is detachably fastened to an extension 45 of the connecting piece 21. On its end closer to the mask 20, the connecting piece 21 has a ring 51, which can be made of plastic, for example, and which is placed over the porous reservoir body 28. On the inside, it is provided with short, thorn-like projections 57 which, when the ring is placed over the reservoir body, dig into the latter and thus effect a solid, clamped connection. On the outside the ring 51 has two projections 52 that interact with recesses 57 in the extension 45 in the manner of a bayonet connection. When the parts are in the installed position, the filter block 28 and the ring 51 are under a certain bias which is exerted by a gasket 53 which is made of elastomer material, preferably silicon rubber. This gasket 23 is braced by means of a spacer ring 54 between the ring 52 and a ring-shaped projection 41 of the extension 45. A layer 55 of filter paper is thereby clamped between the ring-shaped projection 41 and the gasket 53, and runs transversely through the passage for the warm air flowing out of the space 40 toward the connecting piece 21.

The outside wall 32 is provided on its upper end area on the inside with recesses 56 which interact with radial lugs 60 located on the extension 45 of the connecting piece 21, also in the manner of a bayonet connection. In other words, after a rotation of the outside wall with the parts located on it with respect to the extension 45, the part 23, as shown in Figure 3, can be axially removed from the upper portion of the device which consists essentially of the mask 20, the connecting piece 21 and the liquid reservoir 28. It is then also possible, by a corresponding rotation of the reservoir block 28 with respect to the connecting piece 21 or its extension 45, to remove the reservoir block from the connecting piece 21.

In the connecting piece 21, a medication carrier 61 is detachably installed which consists of a wick-like part 62, a carrier 63 and a screw cap 64. The wick which is saturated with a medication, in general an inhalant, is introduced into the connecting piece 21 through an opening in the wall of said connecting piece 21, whereby the screw cap can be screwed onto a nozzle 65 of the connecting piece 21 that is provided with a male thread.

The connecting piece 21 is provided between the nozzle 65 and the mask 20 with a second nozzle 66 that projects outward, which defines an opening into which a hygrometer 68 can be inserted, the parts of which that respond to the relative humidity are passed over by the air that flows through the interior of the connecting piece 21. The hygrometer 68 is provided on the upper side with a scale 69, which is associated with a

pointer 70 which is controlled by the parts of the hygrometer 28 that respond to the relative humidity. The current relative humidity can therefore be read on the scale 69 on the basis of the position of the pointer 70.

72 indicates an opening in the wall of the connecting piece 21, the size of which can be adjusted by a slide (not shown) and optionally can also be completely closed. This opening is used to regulate the temperature of the warm air that flows out of the space 40. As a function of the current setting of the slide that determines the size of the opening, more or less cool air flows directly from outside into the connecting piece 21. It is also possible to instead make it possible to set the thermostat 27 from outside.

73 is a one-way valve which prevents air that is exhaled into the mask 20 from getting into the connecting piece 21. A second, ring-shaped one-way valve 74 which is associated with the mask 20 opens in response to the overpressure of the exhaled air, but prevents the entry of outside air when the patient inhales.

Figure 3 shows the reservoir body 28 that hangs on the extension 45 of the connecting piece 21, after the reservoir body 28 has been extracted upward from the part 23 or the part 23 has been pulled downward. It then becomes possible to introduce the reservoir body 28 into a separate container 76 which has a ring-shaped space 77, the dimensions of which are adapted to those of the hollow-cylindrical reservoir body 28. The ring-shaped space 77 is tapered in its lower portion 78, so that the radial dimension at that point is approximately equal to the wall thickness of the reservoir body 28. It is thereby possible for the liquid that is in the lower portion 78, some of which is displaced upward when the reservoir body 28 is inserted, to penetrate very rapidly into the reservoir body.

Figure 4 shows that a filter paper 80 is provided with which the container 76 can be covered on the top, to allow the water that is to be placed in the container 76 to run through this filter. In this manner it becomes possible to hold back any solids and bacteria that may be in the water. After the filling process has been completed, the filer paper 80 is removed, so that the reservoir body 28 can be inserted in the manner described above.

The detachable and thus replaceable filter paper 55 clamped between the gasket 53 and the ring-shaped extension 41, is in general more permeable than the filter paper 80, to prevent a significant increase in the respiratory resistance of the overall device. The

drawing shows that the replacement of the filter paper 55 is not at all difficult. All that is necessary, after the removal of the part 33 from the upper portion of the device, is to also remove the reservoir body 28 by means of a rotational movement. Then the spacer ring 54, the gasket 53 and the filter paper 55 can also be removed. After a fresh filter paper has been inserted, the parts can then be re-assembled in the reverse order.

The essential parts of the mask, including but not limited to the connecting piece 21 with the extension 45 and the wall parts 31 and 32, can be made of plastic, so that it is possible to mold the nozzle 66 that holds the hygrometer 68 in a single process. The housing of the hygrometer, which is provided with openings for the entry of the air, can be made of sheet metal, so that it can be impressed into the nozzle 76, where it is held by friction. It is also possible, between the housing of the hygrometer 68 and the nozzle 66 to create a sort of tongue-and-groove connection, whereby on account of the elasticity of the interacting materials, a projection that encircles the housing of the hygrometer 68 can be pressed without any additional measures into a groove on the inside of the nozzle 66.